Method and Installation for Producing Carbon Monoxide by Cryogenic Distillation

The present invention relates to a method and an installation for producing carbon monoxide by cryogenic distillation.

The synthesis gas produced by partial oxidation or by reforming often contains a percentage of nitrogen.

All the percentages mentioned are mole percentages.

It is known to reduce the percentage of nitrogen in the carbon monoxide produced by using a nitrogen and carbon monoxide separating column (EP-A-928936).

It is one object of the present invention to provide a cryogenic separation installation for producing carbon monoxide substantially containing no nitrogen using fewer columns than the installations of the prior art.

According to one object of the present invention, a method is provided for producing carbon monoxide by cryogenic distillation comprising the following steps:

i) a gas mixture containing carbon monoxide, hydrogen and nitrogen is cooled and partially condensed to produce a cooled and partially condensed gas mixture

ii) the cooled and partially condensed gas mixture is separated to produce a hydrogen-enriched gas and a carbon monoxide-enriched liquid

iii) a stream of the carbon monoxide-enriched liquid is sent to a stripping column to produce hydrogen-free liquid carbon monoxide and hydrogen-enriched carbon monoxide gas

iv) a stream of the hydrogen-free carbon monoxide is sent to a first intermediate level of a distillation column

v) a liquid stream, richer in methane compared to the stream feeding to the distillation column, is withdrawn from the bottom of the distillation column

vi) a carbon monoxide-rich stream is withdrawn from a second intermediate point, the second intermediate point being above the first intermediate point

vii) a stream, enriched with nitrogen and optionally hydrogen compared to the stream feeding to the distillation column, is withdrawn from the top of the distillation column

Optionally:

- the carbon monoxide-rich stream withdrawn from the distillation column is a liquid stream;
- a carbon monoxide cycle cools the top of the distillation column and/or heats the bottom of the distillation column and/or heats the bottom of the stripping column;
- cycle carbon monoxide is expanded in a turbine.

According to a further object of the invention, an installation is provided for producing carbon monoxide by cryogenic distillation comprising:

a) a heat exchanger for cooling and partially condensing a gas mixture containing carbon monoxide, hydrogen and nitrogen to produce a cooled and partially condensed gas mixture

b) a separator for separating the cooled and partially condensed gas mixture to produce a hydrogen-enriched gas and a carbon monoxide-enriched liquid

c) means for conveying the cooled and partially condensed gas mixture from the heat exchanger to the separator

d) a stripping column and means for conveying at least part of the carbon monoxide-enriched liquid thereto

e) means for withdrawing a hydrogen-enriched gas from the top of the stripping column and means for

withdrawing a hydrogen-free liquid from the bottom of the stripping column

f) a distillation column, means for sending a stream of the hydrogen-free liquid to a first intermediate point of the distillation column, means for withdrawing a bottom liquid from the distillation column, means for withdrawing an overhead gas from the distillation column and means for withdrawing an intermediate fluid at a second intermediate point of the distillation column, the second intermediate point being above the first intermediate point.

Optionally:

- the distillation column has a top condenser and/or a bottom reboiler;
- the stripping column has a bottom reboiler;
- the column (columns) is (are) heated and/or cooled using a carbon monoxide gas cycle.

The invention is described in greater detail with reference to the single figure.

In the figure, a synthesis gas 1 containing 40% hydrogen, 58% carbon monoxide, 0.1% methane, 0.5% nitrogen and 1.3% argon.

This gas is cooled in a heat exchanger 3 to form a cooled stream 5 that is sent to a separator pot 7 where it is partially condensed. The hydrogen rich gas formed 9 is heated in the heat exchanger 3 and sent to a consumer.

The liquid 11 is expanded in a valve 13 to form a stream 15. The liquid stream 15 is sent to the top of a stripping column 17 heated at the bottom by a stream Q1 sent to the bottom reboiler, which may, for example, be part of a carbon monoxide cycle. A hydrogen-enriched waste gas stream RSD leaves the top of the stripping column 17. A hydrogen-free liquid stream 19 is withdrawn from the bottom of the column 17, expanded in the valve 21 and sent to an intermediate point of a distillation column 23. The column 23 is heated at the bottom by a stream Q2 sent

to the bottom reboiler and cooled at the top by a stream Q3 sent to the top condenser, the two streams possibly forming part of a carbon monoxide cycle.

A methane-rich liquid stream 27 is withdrawn from the bottom of the column 23. A carbon monoxide-rich liquid stream 29 is withdrawn at an intermediate point above the point of arrival 19 of the liquid. This liquid preferably contains 98.5% carbon monoxide, less than 1% argon, less than 10^{-2} ppm methane and 0.4% nitrogen. A gas mixture of hydrogen and nitrogen RSD N2 is withdrawn from the top of the distillation column 3.

The stream RSD N2 is mixed with the stream RSD from the column 17 and leaves the installation to be discharged to the atmosphere and/or burned after being heated in the heat exchanger 3.

The liquid 29 joins a stream of liquid 31 issuing from the cycle and the mixed stream is expanded in a valve 33 before being heated in the heat exchanger 3 to form the product 35.

The installation is kept cold by a carbon monoxide gas turbine 37, expansion of another fluid and/or by liquid injection.